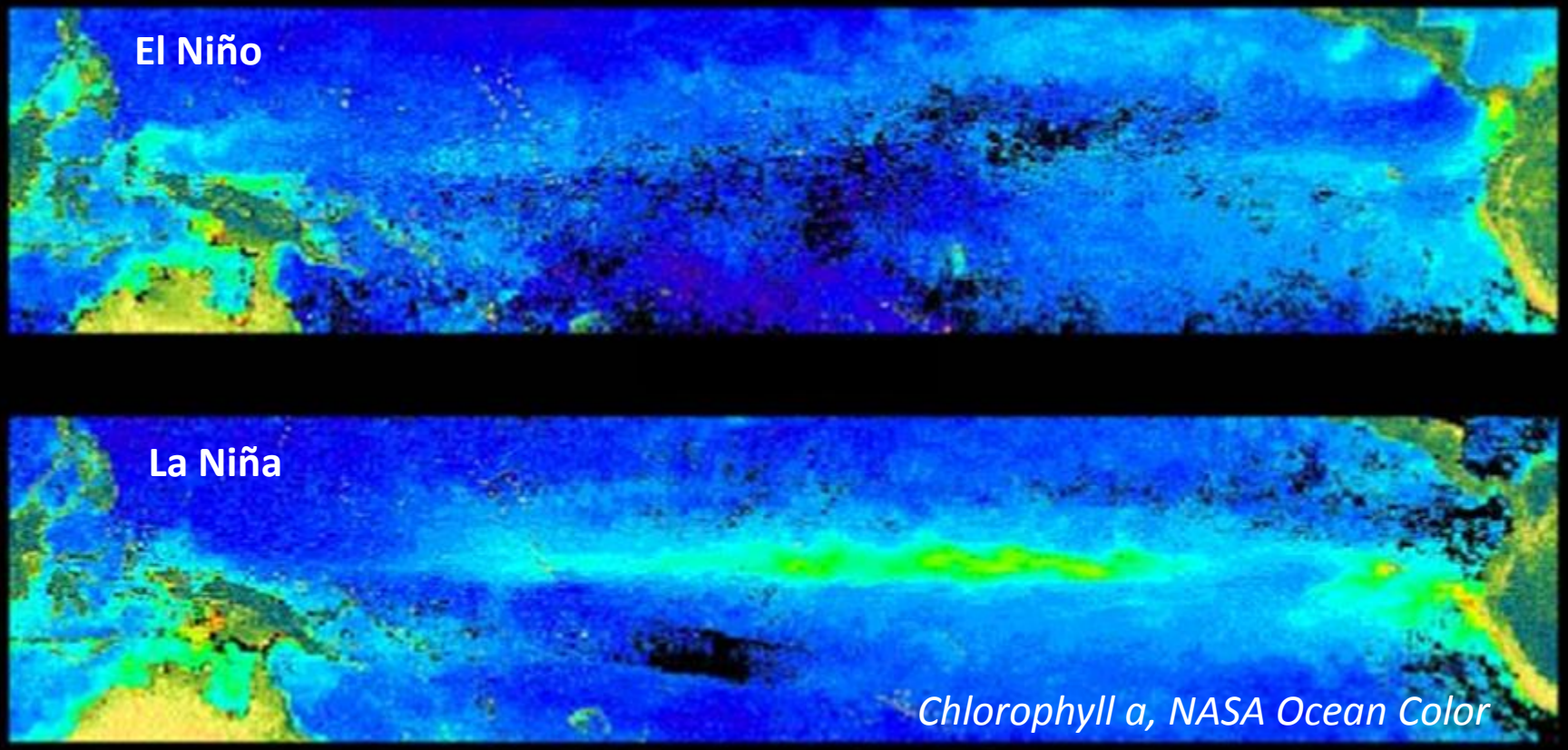
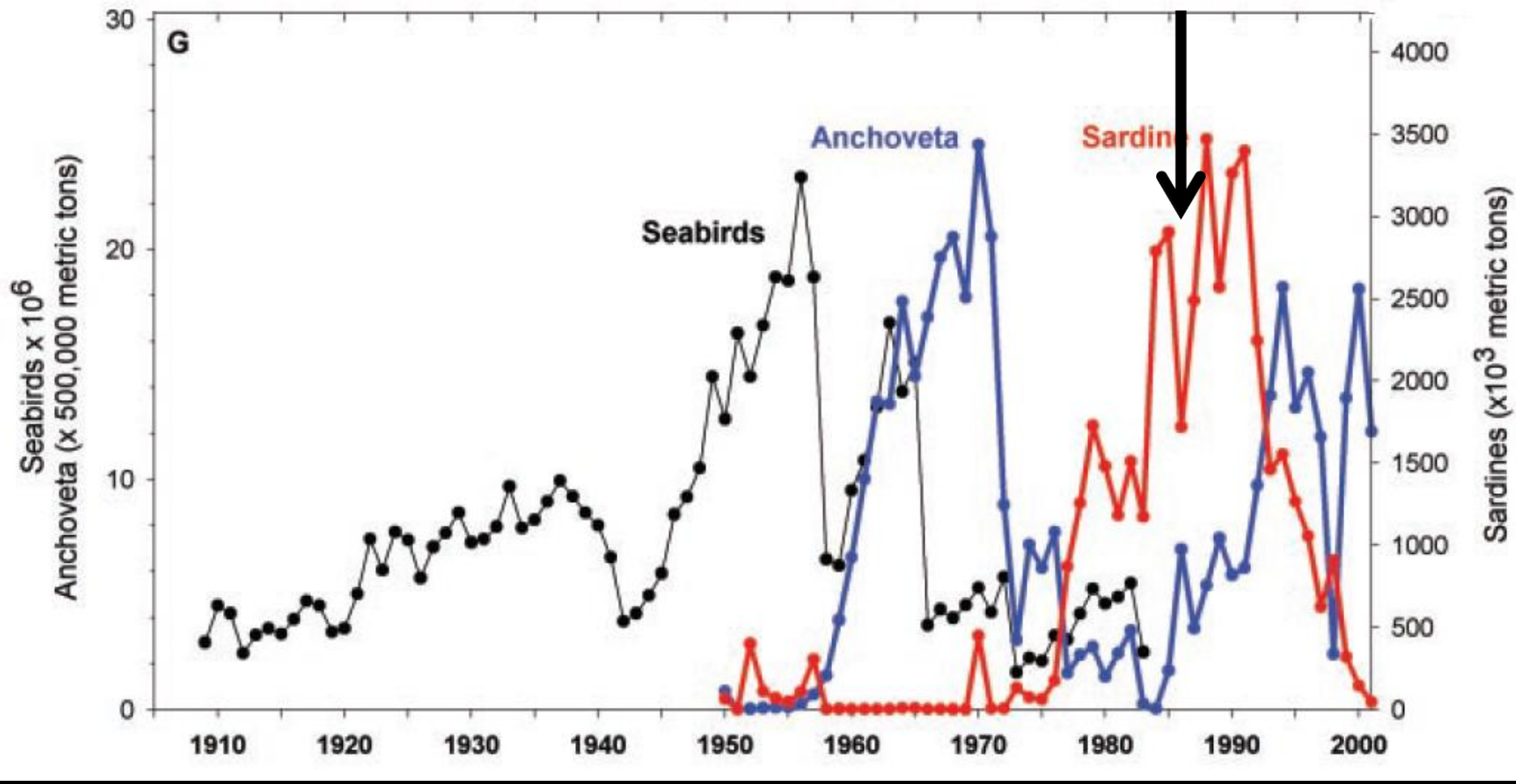
Climate Variability and Phytoplankton Composition in the Pacific Ocean

Presented by James Acker
Authors: Rousseaux C.S., Gregg W.W.,



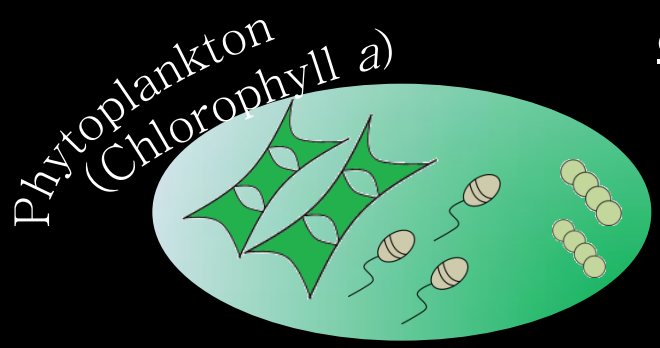
Gregory G. Leptoukh 2012 Online Giovanni Workshop
September 25-27, 2012, Greenbelt, MD



Seabird abundance and anchoveta and sardine landings from Peru (Chavez et al. 2003)

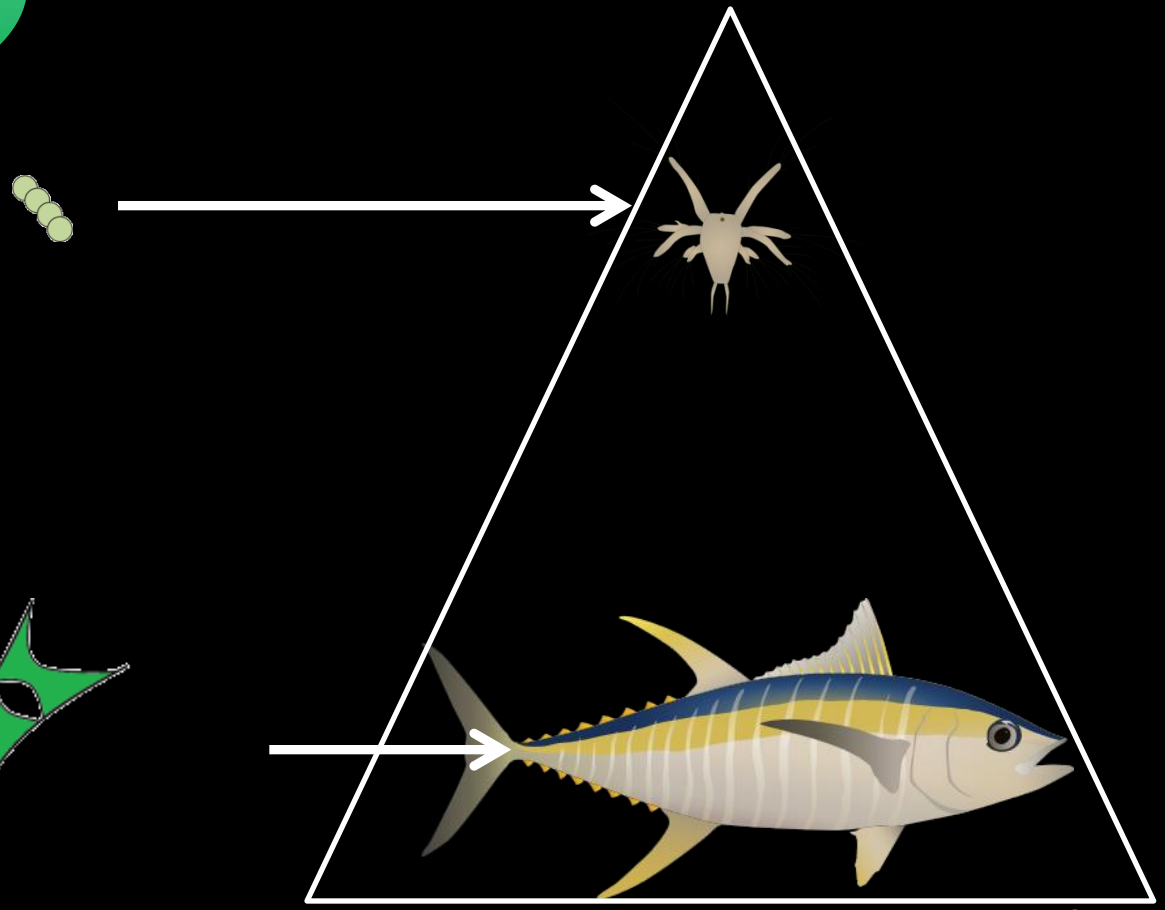
When it comes to feeding fishes,

all phytoplankton are not equal…



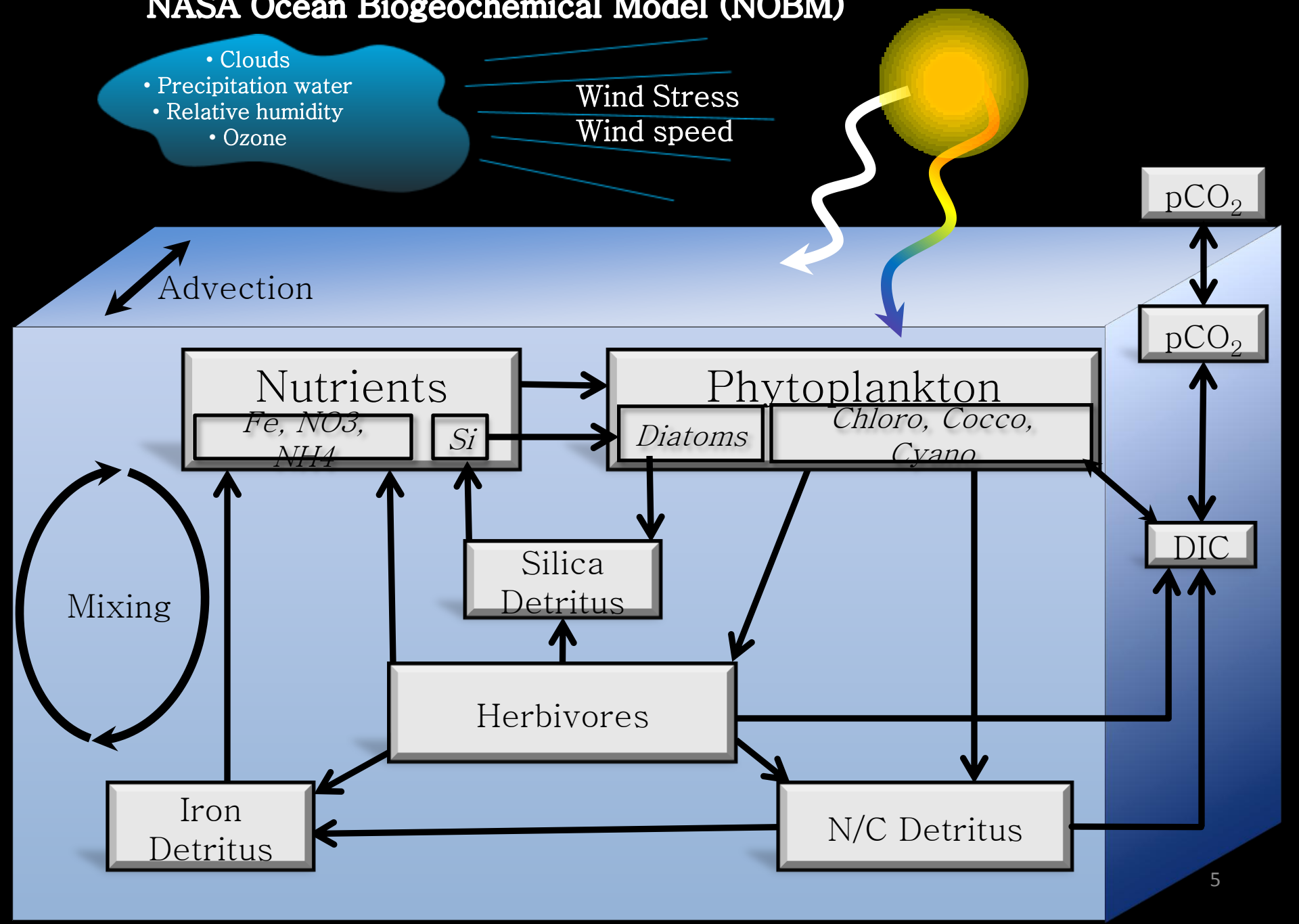
Chlorophyll *a*

- Cyanobacteria
- Coccolithophores
- Chlorophytes
- Diatoms



Are El Niño conditions unfavorable to all phytoplankton groups or only some?

NASA Ocean Biogeochemical Model (NOBM)



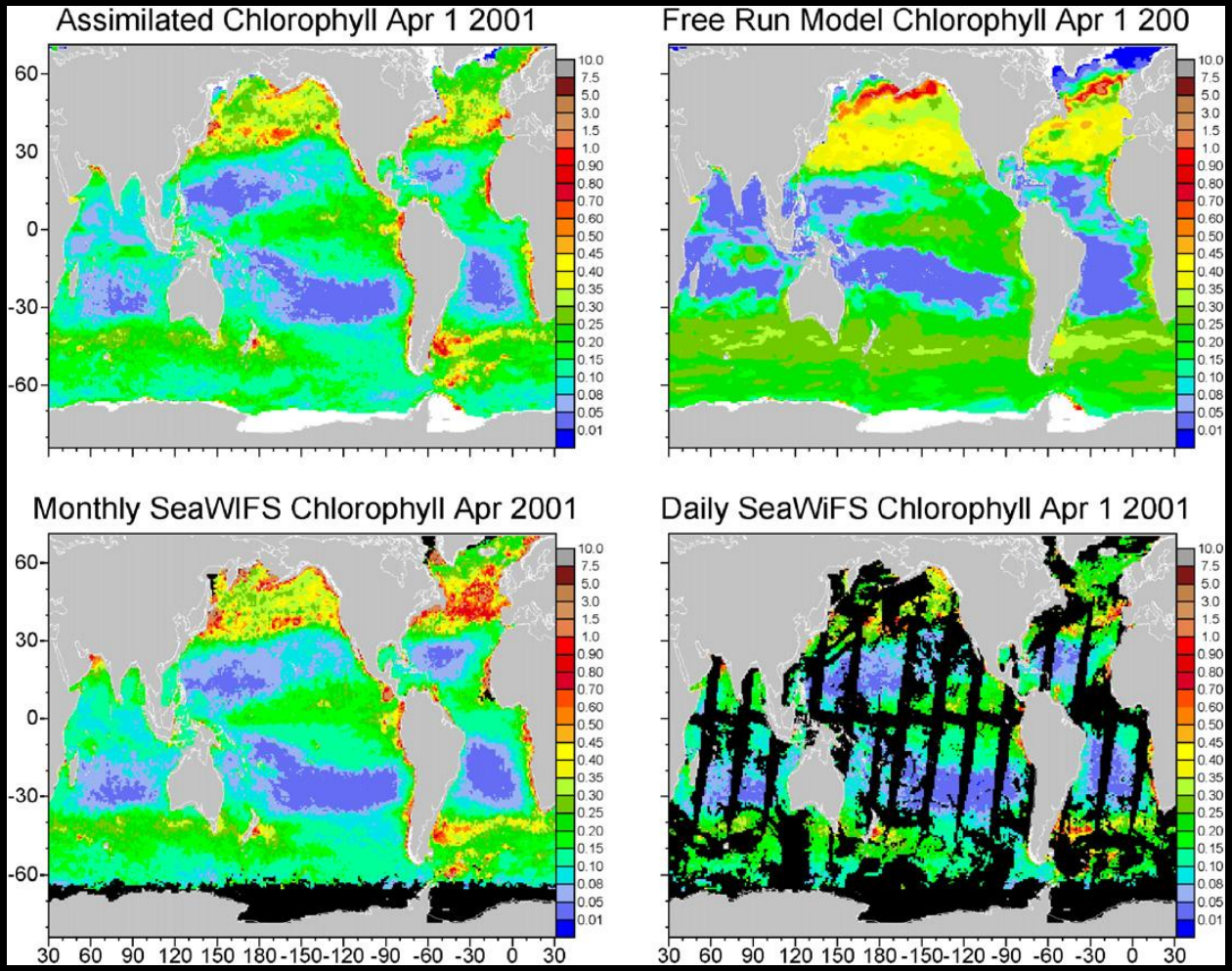
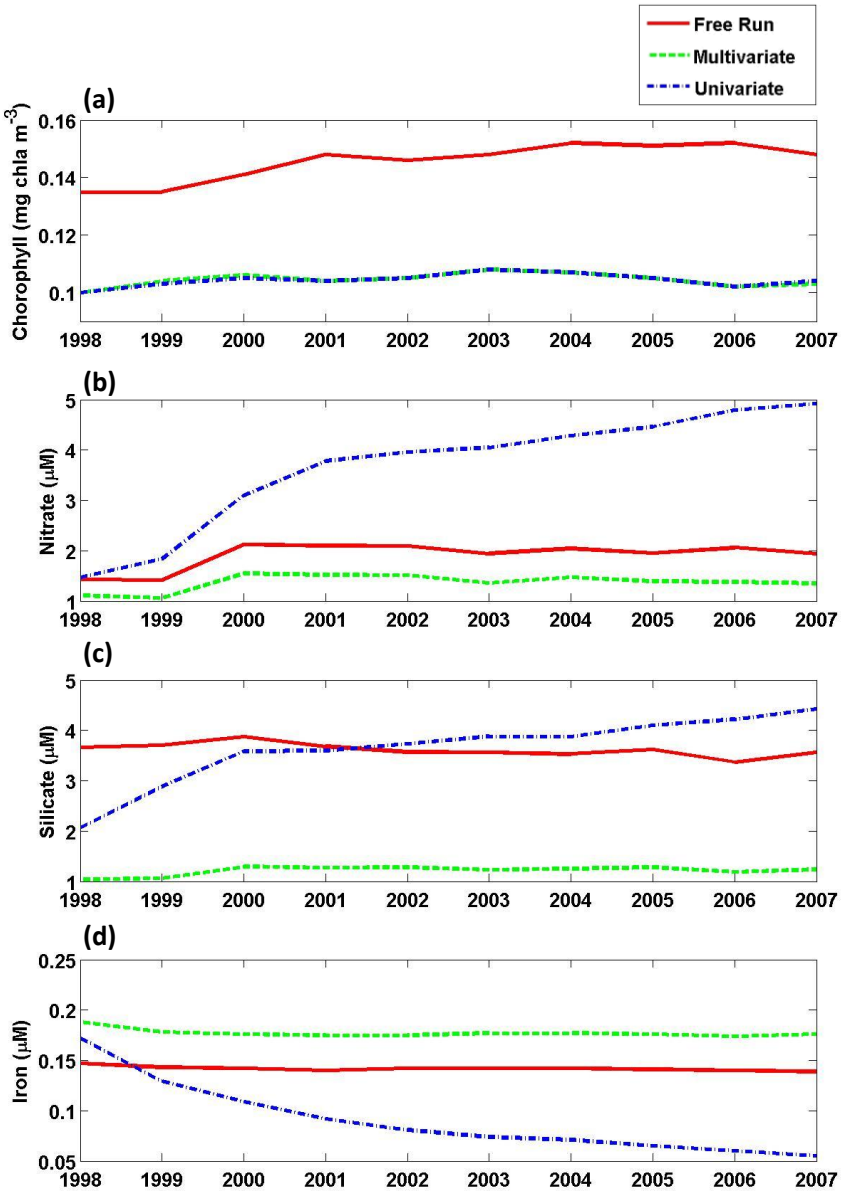
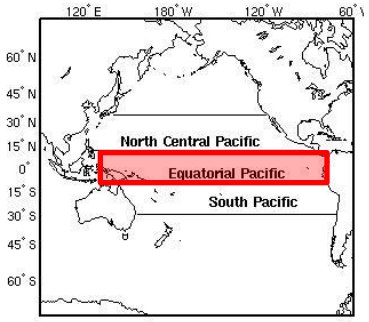


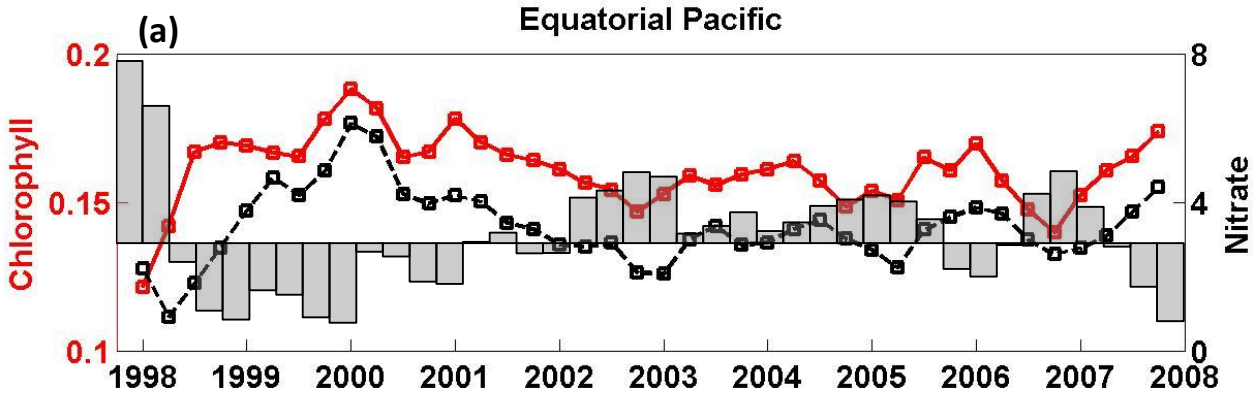
Figure 2| Comparison of chlorophyll (mg m^{-3}) from the assimilation model, the free-run model, and SeaWiFS. The assimilation and free-run chlorophyll distributions represent simulations for April 1, 2001. SeaWiFS data for the same day are shown for comparison, along with the monthly mean. Grey indicates land and coast, black indicates missing data, and white indicates sea ice.

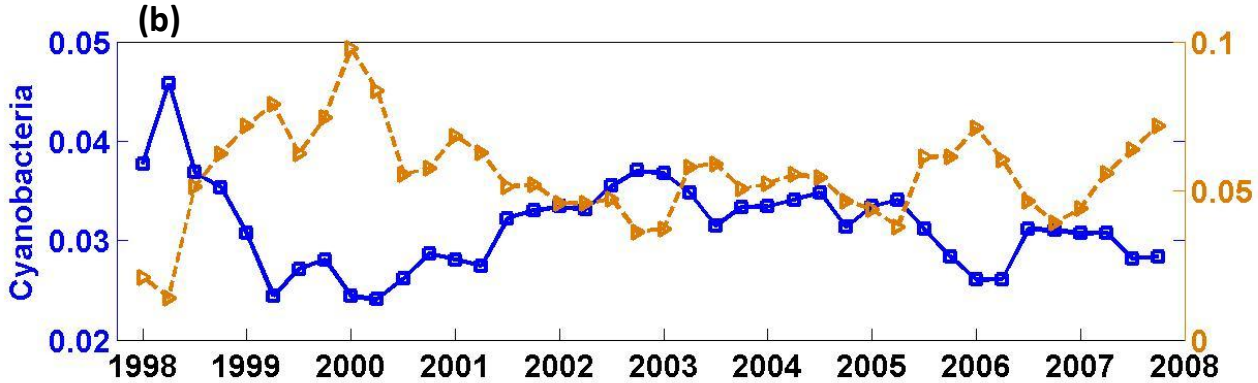
	Bias	Uncertainty	N
SeaWiFS	-1.3%	32.7%	2086
Free-run Model	-1.4%	61.8%	4465
Assimilation Model	0.1%	33.4%	4465

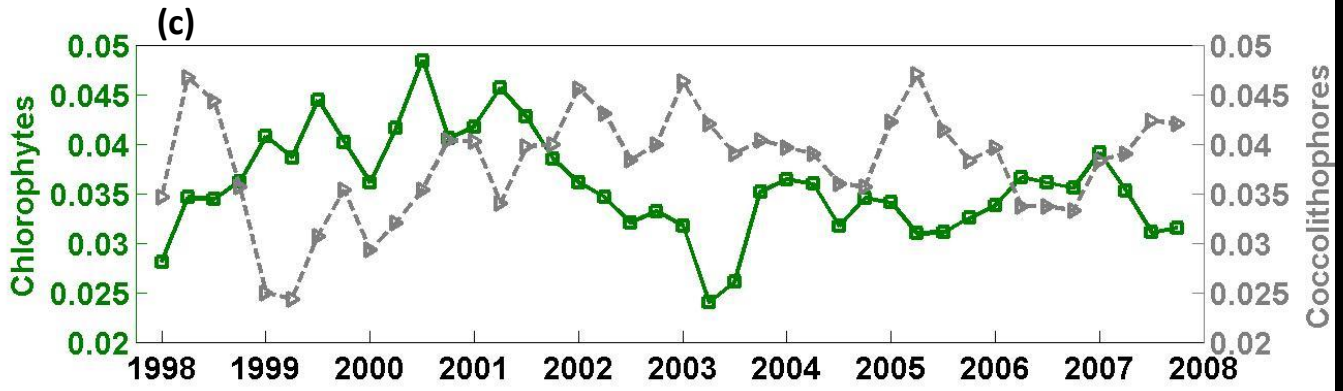


Comparison of the free run, the multivariate and the univariate approach for chlorophyll and nutrients in the South Pacific Ocean. Time series of annual averages of (a) Chlorophyll, (b) Nitrate, (c) Silicate and (d) Iron. [Rousseaux & Gregg 2012]


120° E
180° W
120° W
60° W
60° N
45° N
30° N
15° N
0°
15° S
30° S
45° S
60° S
North Central Pacific
Equatorial Pacific
South Pacific


Equatorial Pacific
(a)
Chlorophyll
Nitrate
0.2
0.15
0.1
8
4
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008


(b)
Cyanobacteria
Diatoms
0.05
0.04
0.03
0.02
0.1
0.05
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008


(c)
Chlorophytes
Coccolithophores
0.05
0.045
0.04
0.035
0.03
0.025
0.02
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008

(a) North Central Pacific

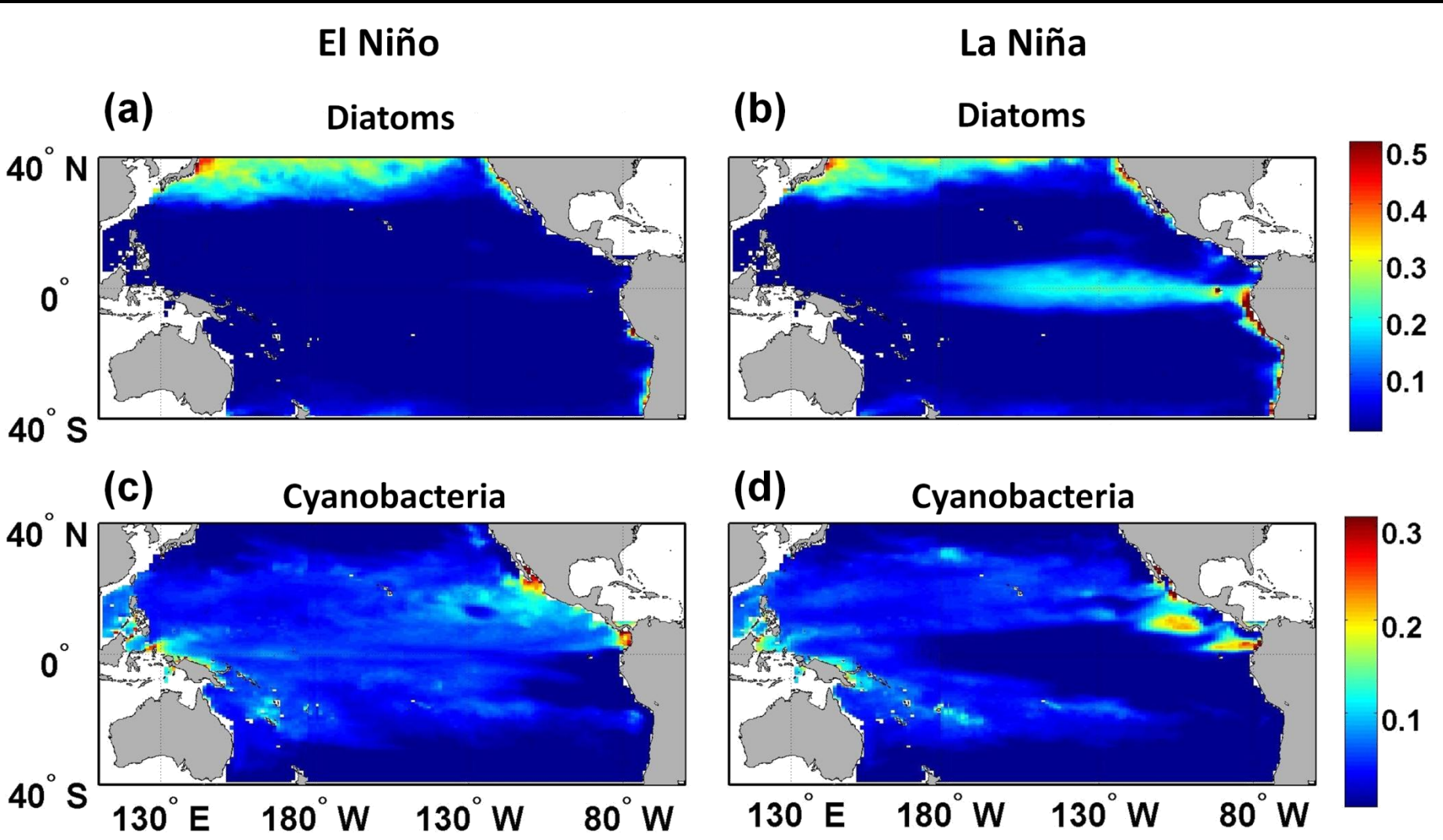
	MEI	Nitrate	Diatoms	Chlorophytes	Cyanobacteria	Coccolithophores
MEI	1.00	-	-	-	-	-
Nitrate	0.17	1.00	-	-	-	-
Diatoms	**-0.40***	**0.42***	1.00	-	-	-
Chlorophytes	**-0.43***	-0.26	-0.01	1.00	-	-
Cyanobacteria	0.17	-0.15	**-0.38***	-0.02	1.00	-
Coccolithophores	-0.14	-0.10	-0.03	0.24	0.03	1.00
Total Chlorophyll	**-0.50***	0.00	**0.44***	**0.67***	0.25	**0.50***

(b) Equatorial Pacific

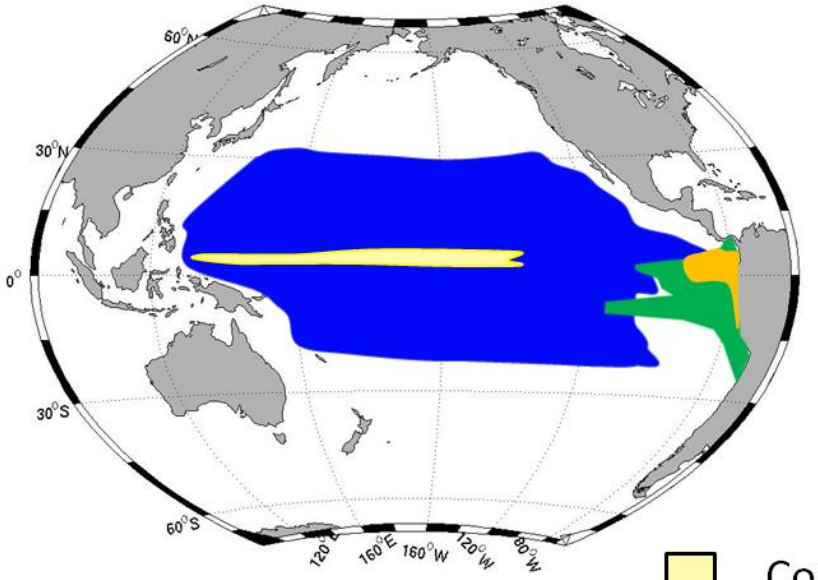
	MEI	Nitrate	Diatoms	Chlorophytes	Cyanobacteria	Coccolithophores
MEI	1.00	-	-	-	-	-
Nitrate	**-0.71***	1.00	-	-	-	-
Diatoms	**-0.87***	**0.91***	1.00	-	-	-
Chlorophytes	**-0.39***	**0.43***	0.29	1.00	-	-
Cyanobacteria	**0.69***	**-0.88***	**-0.81***	**-0.46***	1.00	-
Coccolithophores	**0.33***	**-0.60***	**-0.53***	**-0.42***	**0.57***	1.00
Total Chlorophyll	**-0.89***	**0.77***	**0.89***	**0.44***	**-0.63***	-0.22

(c) South Pacific

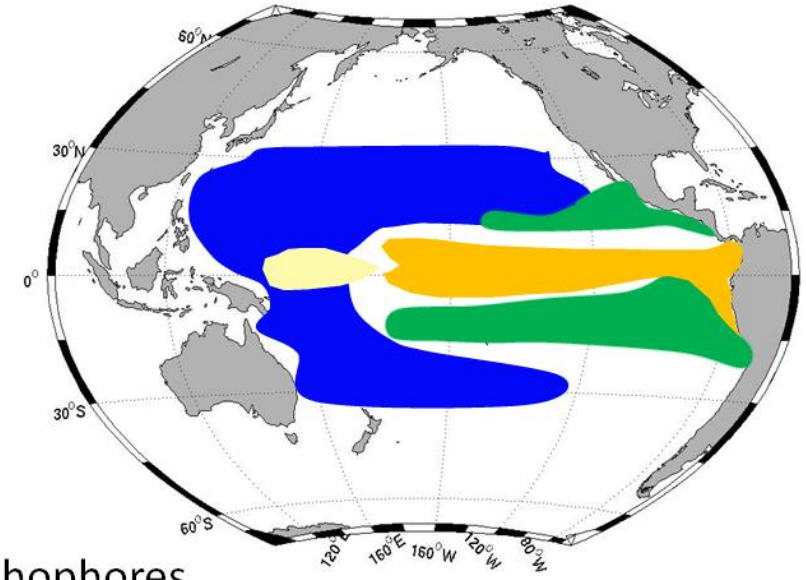
	MEI	Nitrate	Diatoms	Chlorophytes	Cyanobacteria	Coccolithophores
MEI	1.00	-	-	-	-	-
Nitrate	0.19	1.00	-	-	-	-
Diatoms	0.18	**0.73***	1.00	-	-	-
Chlorophytes	0.08	0.18	0.22	1.00	-	-
Cyanobacteria	-0.15	**-0.49***	**-0.66***	**-0.49***	1.00	-
Coccolithophores	-0.01	-0.06	-0.14	-0.03	**0.33***	1.00
Total Chlorophyll	0.10	**0.43***	**0.56***	**0.64***	-0.21	**0.42***


El Niño
La Niña
(a)
Diatoms
(b)
Diatoms
40° N
0°
40° S
0.5
0.4
0.3
0.2
0.1
(c)
Cyanobacteria
(d)
Cyanobacteria
40° N
0°
40° S
0.3
0.2
0.1
130° E
180° W
130° W
80° W
130° E
180° W
130° W
80° W

El Niño



La Niña



Coccolithophores

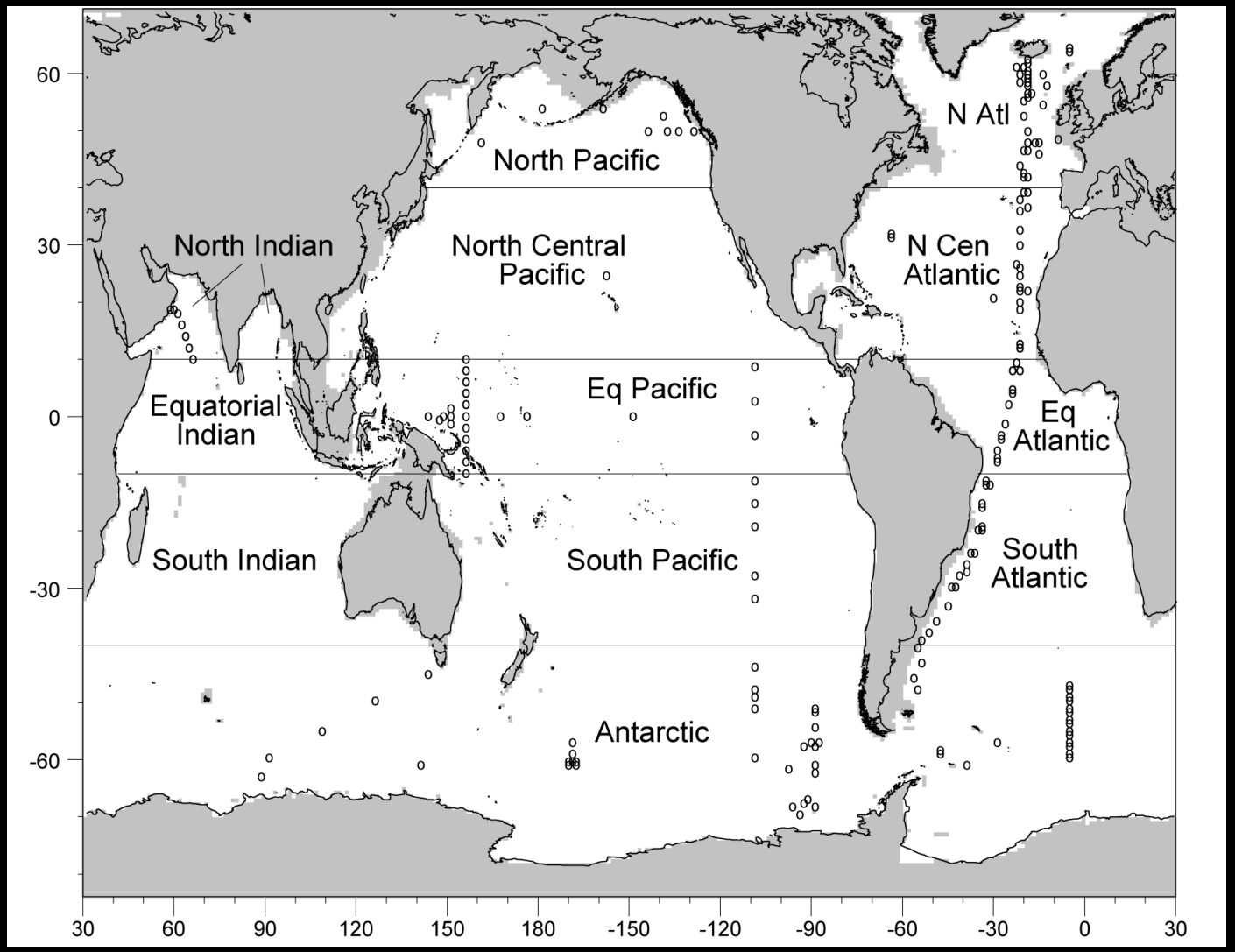
Chlorophytes

Diatoms

Cyanobacteria

How well does the NOBM compare to in situ data?

Global Phytoplankton Relative Abundance



469 observations taken from figures in peer-reviewed papers; Available at GMAO Web site

How well does the NOBM compare to in situ data?

	North Central Pacific	Equatorial Pacific	South Pacific
Diatoms	-3.50 (3)	-0.87 (21)	25.58 (7)
Chlorophytes	-19.40 (2)	-18.01 (17)	-33.32 (7)
Cyanobacteria	10.67 (24)	-13.47 (20)	3.20 (2)
Coccolithophores	1.99 (3)	36.77 (15)	-2.11 (7)

Percentage difference between the NOBM and the in situ data. The number of observations used for the comparison is between parenthesis

Only >20% in 3 cases

Conclusion:

1. Climate variability has most impact on the phytoplankton community composition in the Equatorial Pacific
2. Large Shifts are observed both on temporal and spatial scale
3. These shifts have potential important consequences for the carbon cycles and higher trophic levels

Any questions? Send me an email at Cecile.S.Rousseaux@nasa.gov

This presentation is based on the results presented in

Rousseaux, C.S. & Gregg, W.W. Climate variability and phytoplankton composition in the Pacific Ocean. Journal Of Geophysical Research. In print. 2012